

# Disclosure limitation and confidentiality protection in linked data

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Based on joint work with John M. Abowd and Ian M. Schmutte



# administrative data in the infrastructure of official statistics

- Back to the 1960s – frames, if not surveys
- Motivation behind Fellegi's original work
- Today not just frame but data source
  - European censuses based on administrative data
  - US business registers used for Business Dynamics Statistics (BDS), County Business Patterns
- New sources emerging (health, education, law)



rich new analysis and publications

held back by concerns of citizens  
and businesses about privacy



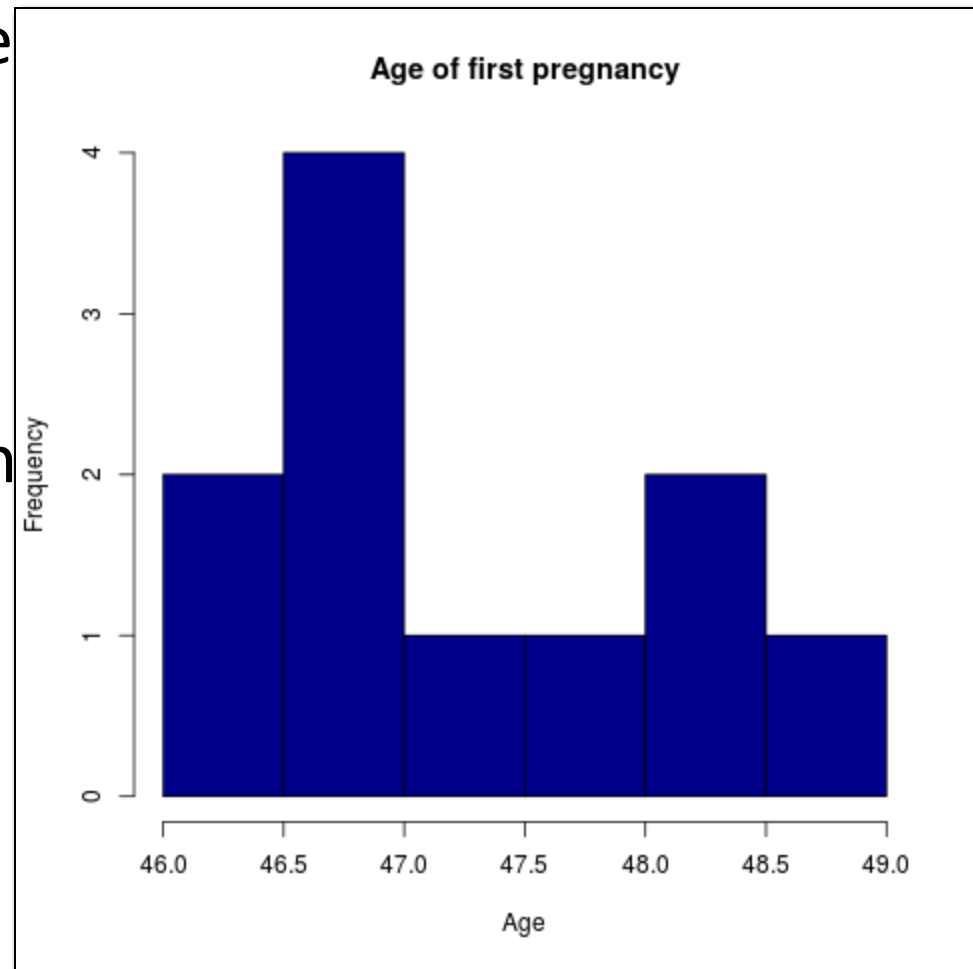
# privacy concerns

- 1960s in the US: proposal for “National Data Bank” with the goal of combining survey and administrative data to make available to researchers
  - Instead, and partially as a consequence, privacy laws were formalized in the 1970s (“Privacy Act 1974” (Public Law 93-579, 5 U.S.C. § 552a)) specifically prohibited “matching” programs, linking data from different agencies.
- More recently: 2016 Australian Census elicited substantial controversy
  - Identifiable data with explicit goal of enabling linkages between the census and administrative data, as well as linkages across historical censuses



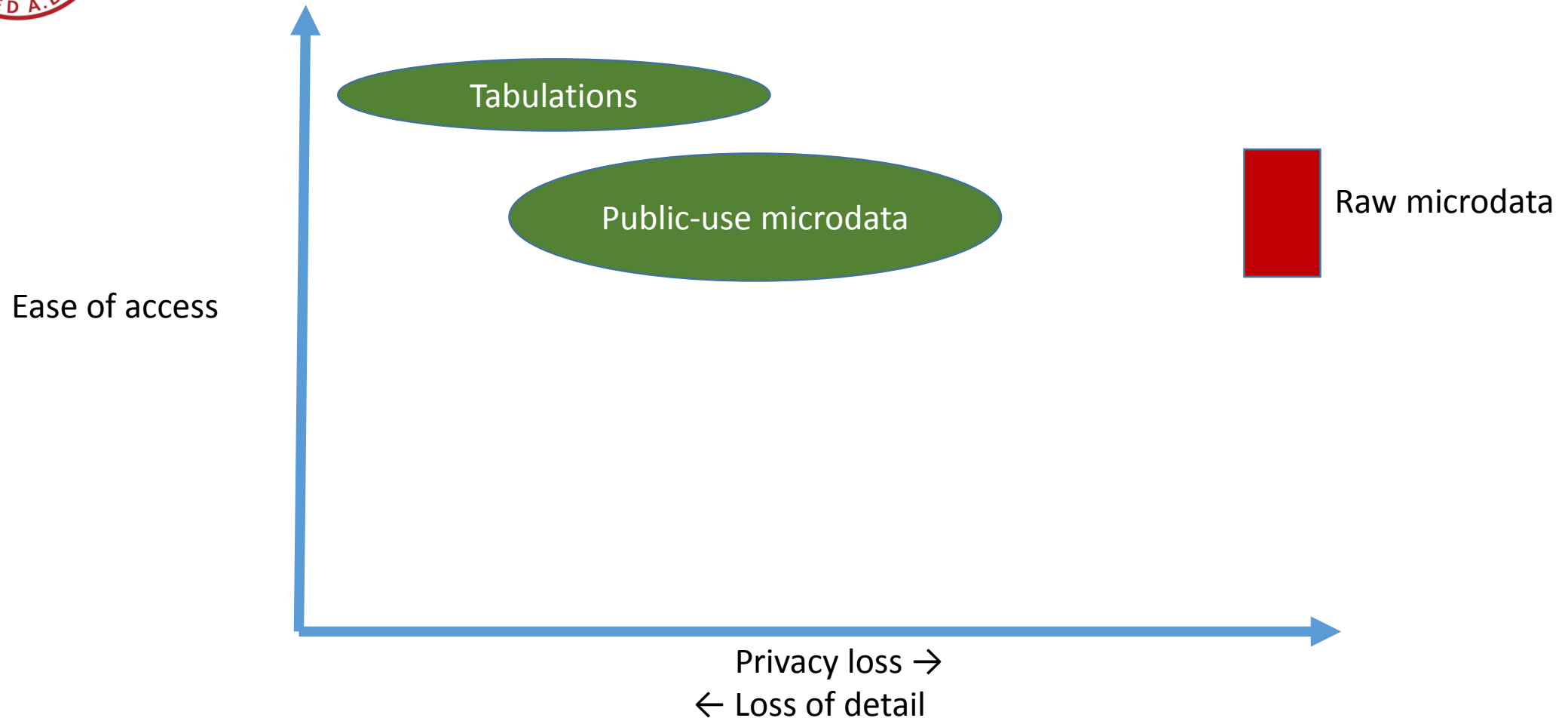
# current state of protection mechanisms

- Public-use files and tabulations, created using techniques developed for survey file
  - Suppression
  - Coarsening
  - swapping
  - noisy queries (input and output)
- Limited utility for “thin tails” (or thin)
  - Business data
  - But more generally “rare data”





# access methods





# focus

I will focus on access mechanisms for researchers



Source: (Fox News/REUTERS/Kacper Pempel/Files/https://goo.gl/ZHMkog)

I will exclude

- Newer mechanisms to create tabular data (synthetic data, differentially-private data)

Table View

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The table contains a total of 45,092 data rows.

Versions of this table are available for the years:

2015 ▾

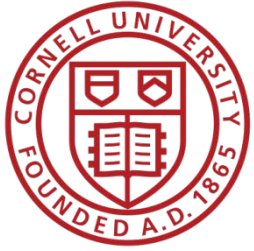
2014

2013

2012

2011

	April 1, 2010		Population Estimate (as of July 1)						
Geography	Census	Estimates Base	2010	2011	2012	2013	2014	2015	
United States	308,745,538	308,758,105	309,346,863	311,719,857	314,102,623	316,427,395	318,907,401	321,418,920	
Alabama	4,779,736	4,780,127	4,785,161	4,801,108	4,816,089	4,830,533	4,846,411	4,858,979	
Alaska	710,231	710,249	714,021	722,720	731,228	737,442	737,046	738,432	
Arizona	6,392,017	6,392,307	6,408,208	6,468,732	6,553,262	6,630,799	6,728,783	6,828,065	
Arkansas	2,915,918	2,915,959	2,922,394	2,938,539	2,949,499	2,957,957	2,966,835	2,978,204	
California	37,253,966	37,254,503	37,334,079	37,700,034	38,056,055	38,414,126	38,792,291	39,144,818	
Colorado	5,029,196	5,029,324	5,048,254	5,119,480	5,191,731	5,271,132	5,355,588	5,456,574	
Connecticut	3,574,097	3,574,118	3,579,717	3,589,759	3,593,541	3,597,168	3,594,762	3,590,886	
Delaware	897,934	897,936	899,791	907,916	917,099	925,353	935,968	945,934	
District of Columbia	601,723	601,767	605,126	620,472	635,342	649,540	659,836	672,228	
Florida	19,801,310	19,804,623	19,849,890	19,105,533	19,352,021	19,594,467	19,905,569	20,271,272	
Georgia	9,887,853	9,888,681	9,713,454	9,812,280	9,917,639	9,991,562	10,097,132	10,214,860	
Hawaii	1,360,301	1,360,301	1,363,980	1,378,227	1,392,641	1,408,765	1,420,257	1,431,603	
Idaho	1,567,582	1,567,652	1,570,986	1,584,134	1,596,097	1,612,785	1,634,806	1,654,930	
Illinois	12,830,632	12,831,549	12,841,249	12,861,882	12,875,167	12,889,580	12,882,189	12,859,995	
Indiana	6,483,802	6,484,229	6,490,590	6,516,845	6,538,283	6,570,518	6,597,880	6,619,880	
Iowa	3,046,355	3,046,969	3,050,694	3,065,389	3,076,636	3,092,224	3,109,491	3,123,899	
Kansas	2,853,118	2,853,132	2,858,824	2,869,917	2,886,281	2,894,630	2,902,507	2,911,641	
Kentucky	4,339,367	4,339,349	4,347,937	4,367,882	4,382,667	4,398,500	4,412,617	4,425,092	
Louisiana	4,533,372	4,533,479	4,544,951	4,575,381	4,603,676	4,627,491	4,648,990	4,670,724	
Maine	1,328,361	1,328,361	1,327,695	1,328,257	1,328,888	1,328,778	1,330,256	1,329,328	
Maryland	5,773,552	5,773,785	5,788,409	5,844,171	5,890,740	5,936,040	5,975,346	6,006,401	
Massachusetts	6,547,629	6,547,817	6,555,036	6,611,797	6,657,780	6,708,810	6,755,124	6,794,422	
Michigan	9,883,640	9,884,129	9,877,369	9,876,589	9,886,879	9,900,506	9,916,306	9,922,576	
Minnesota	5,303,925	5,303,925	5,310,903	5,348,119	5,380,443	5,420,541	5,457,125	5,489,594	
Mississippi	2,967,297	2,968,103	2,970,316	2,977,999	2,985,660	2,990,976	2,993,443	2,992,333	
Missouri	5,988,927	5,988,927	5,996,052	6,010,587	6,025,468	6,043,708	6,063,827	6,083,672	
Montana	989,415	989,417	990,643	997,746	1,005,157	1,014,402	1,023,252	1,032,949	
Nebraska	1,826,341	1,826,341	1,830,025	1,842,383	1,855,973	1,869,300	1,882,890	1,896,190	
Nevada	2,700,551	2,700,691	2,703,440	2,719,819	2,754,874	2,790,366	2,836,281	2,890,845	
New Hampshire	1,316,470	1,316,466	1,316,708	1,318,344	1,321,393	1,322,660	1,327,996	1,330,608	
New Jersey	8,791,894	8,791,936	8,803,881	8,842,934	8,874,893	8,907,384	8,938,844	8,958,013	
New Mexico	2,059,179	2,059,192	2,064,741	2,078,226	2,084,792	2,086,890	2,085,567	2,085,109	
New York	19,378,102	19,378,087	19,402,920	19,523,202	19,606,981	19,691,032	19,748,858	19,795,791	
North Carolina	9,439,493	9,439,693	9,458,979	9,551,026	9,747,021	9,845,430	9,945,307	10,042,903	



# newer methods: Data Enclaves

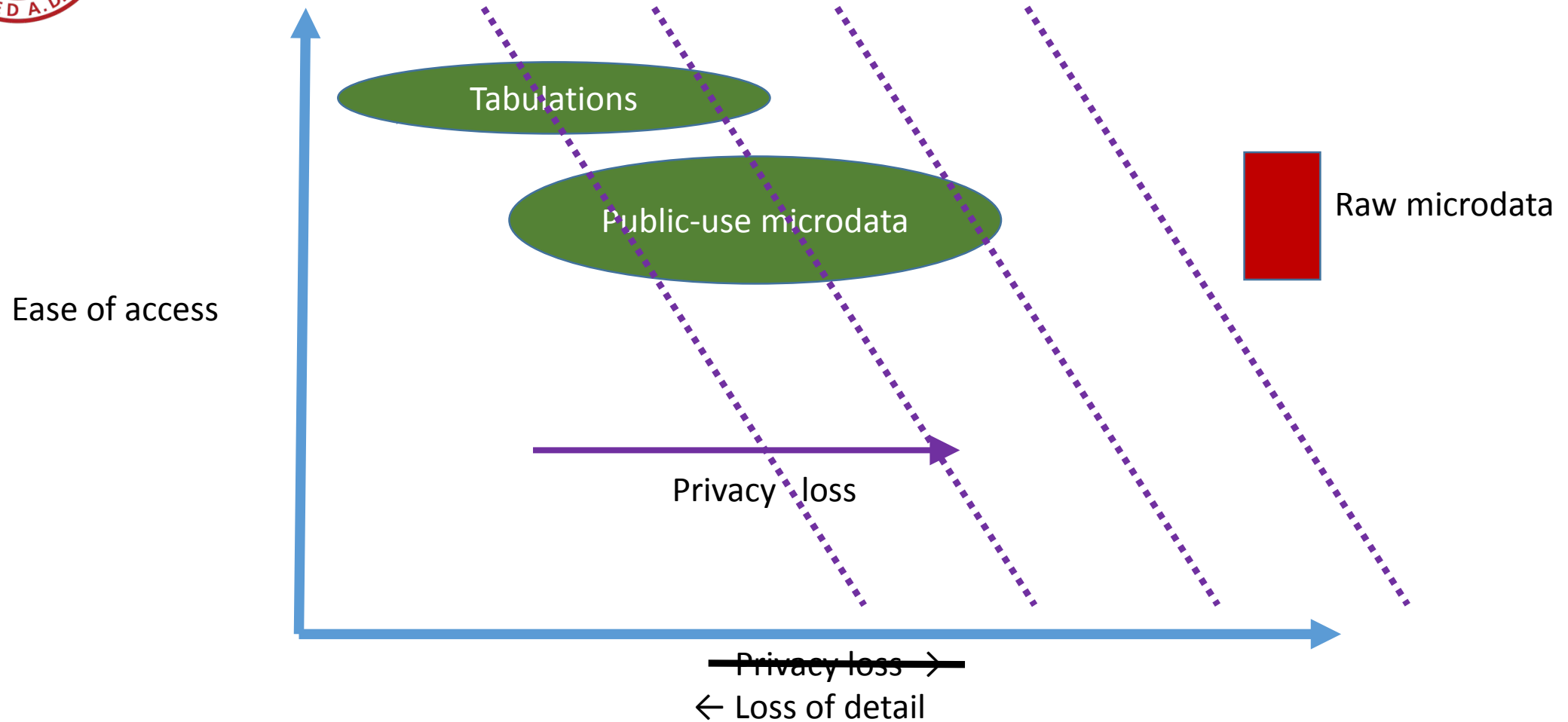
- custom tabulations (by staff) became too onerous
- tabulation and analysis work offloaded onto researchers by providing them with access to protected microdata

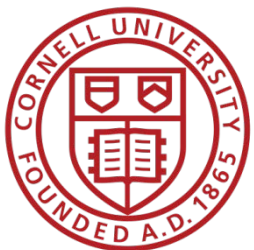




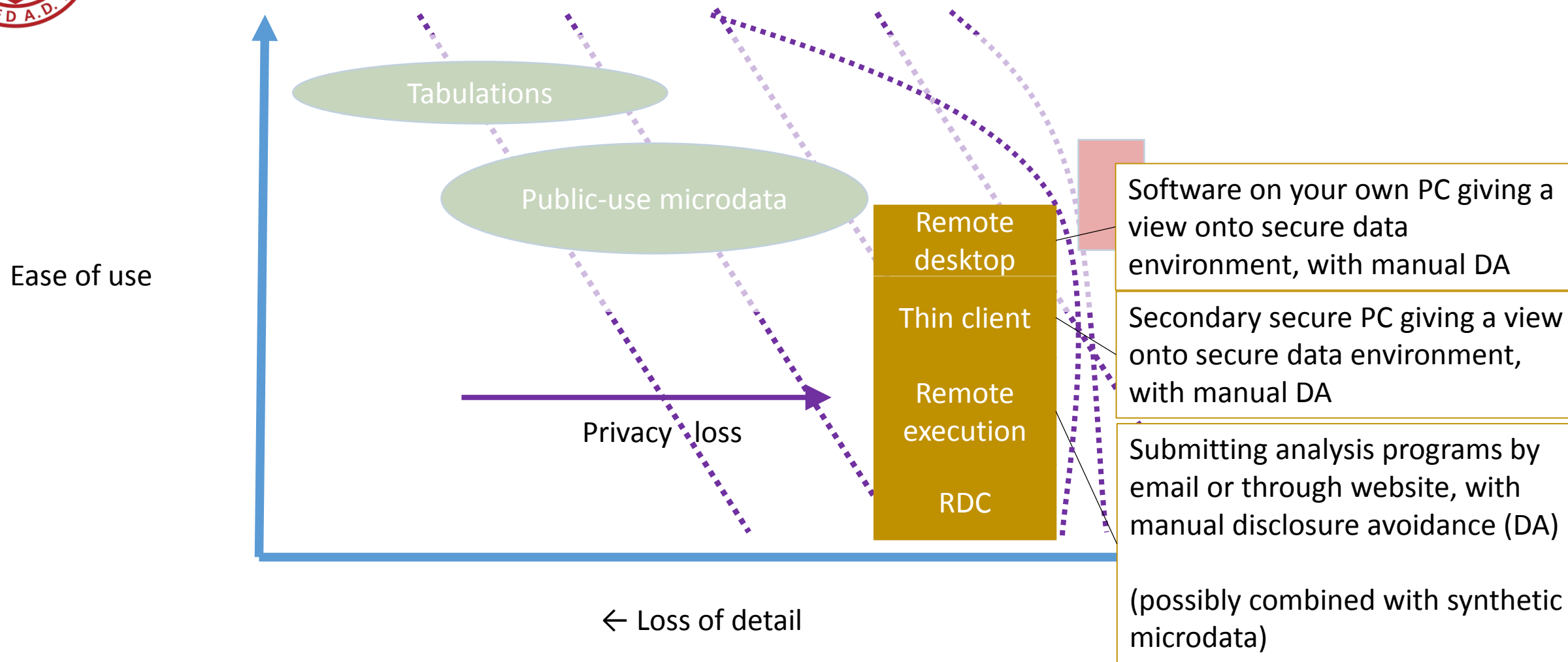


# access methods





# access methods: enclaves

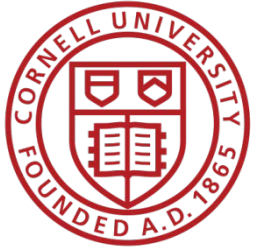




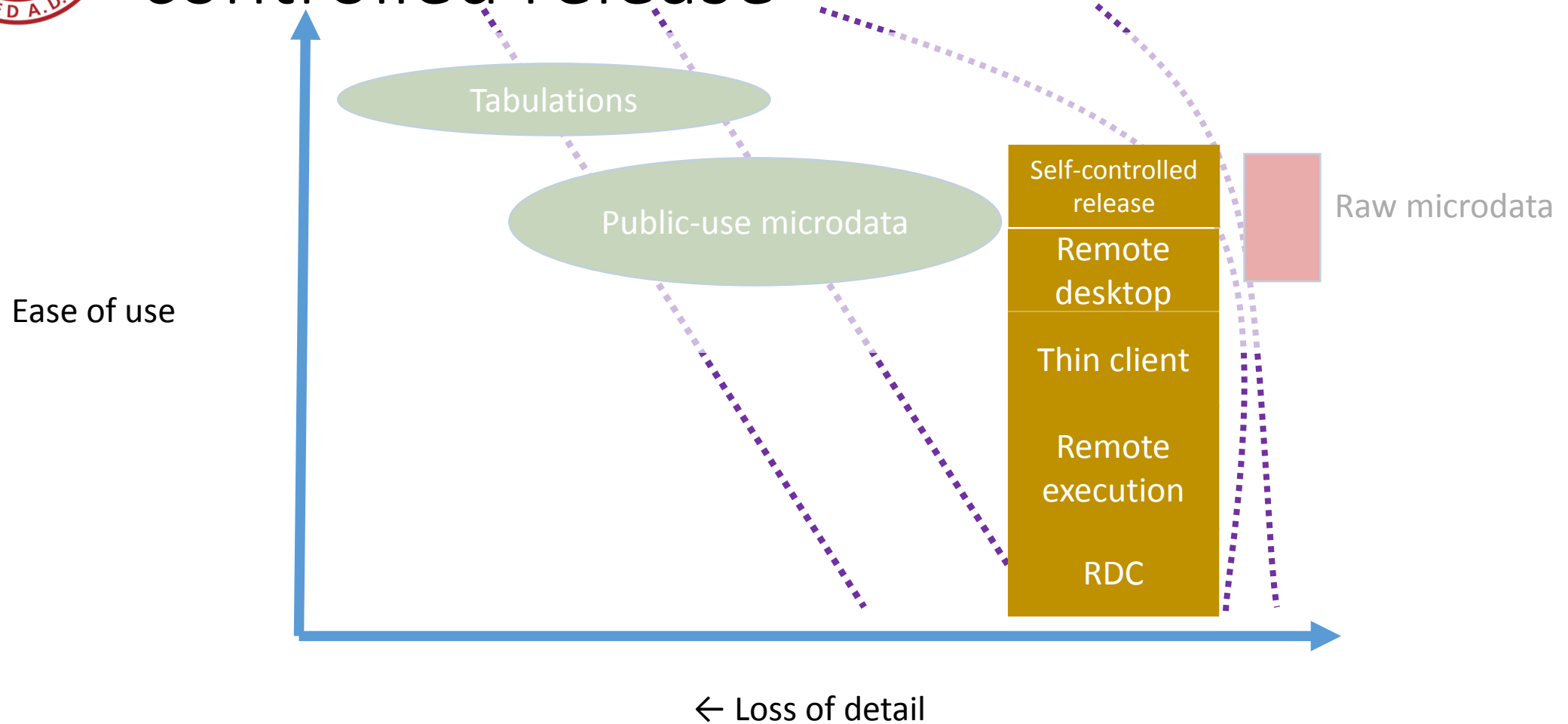
# thin clients

- With the notable exception of the Canadian RDCs (for now), **thin clients** are the preferred method of access
  - Surrounded by **walls** = RDC [FSRDC in US, Germany, others]
  - Embedded in a managed device = “thin client” [above, plus France]
  - Software with a managed access token = “remote desktop” or “VDI” [some US agencies; DK, Finland]
- Additional controls may be
  - IP address control [many] 70.48.1
  - Biometric authentication [France]
  - Smart card [France, US]





# access methods: enclaves with researcher-controlled release



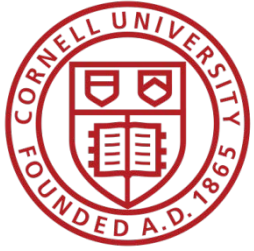


# trust and access

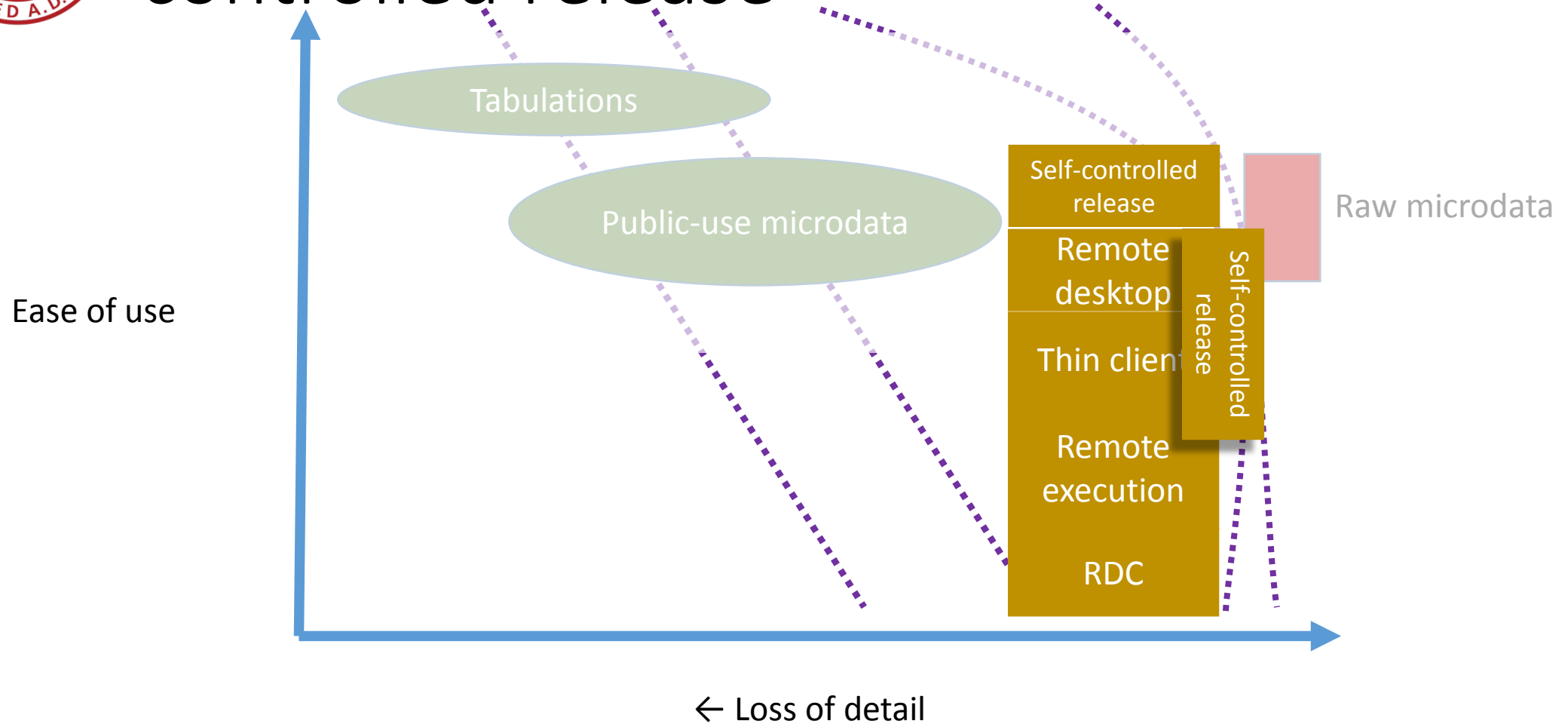
- Frequent discussion
  - Security measures are for (malevolent) **intruders**/opponents
  - Researchers are **trusted** collaborators...
  - ... who **know** what they are doing
- A corollary:
  - Protect against the **bad** guys
  - But let the “**good**” guys do their thing
- Examples:
  - Network-moderated access
  - Contracts with disclosure avoidance rules
  - Danish remote access with **researcher-controlled release** of results and **authorized establishments**

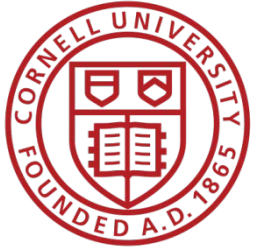
*How do you  
know who the  
good guys are?*

*Also known as the  
“old boys’ network”*

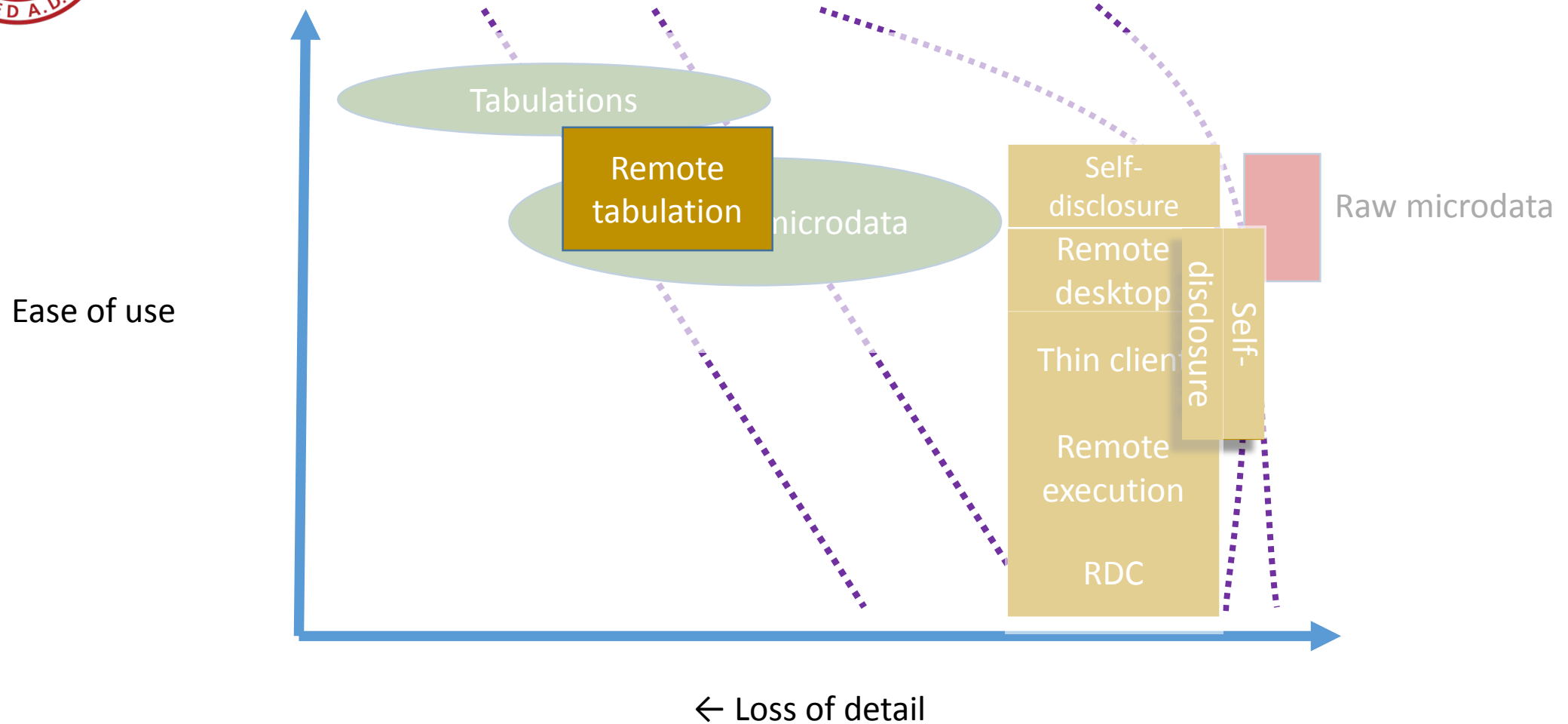


# access methods: enclaves with researcher-controlled release





# access methods: remote tabulation

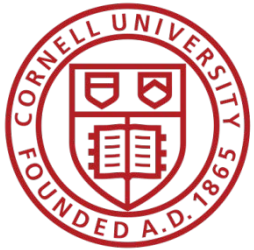




# hidden element: how is Disclosure Avoidance done?

- Most access methods:
  - Enforcing minimum count of entities in a statistic (coefficient, mean, stddev)
  - Prohibiting creation of tabular data (or making it very expensive)
  - (Vain) attempt at tracking overlapping releases
- Automated systems
  - Tracking of cells, implementation of (randomized) rounding, suppression, (output) noise infusion (StatCan, ABS)
  - Similar in CB's Microdata Analysis System/Automated Query System
- Newer mechanisms
  - Noise infusion upon computation
  - Differentially-private output perturbation (of model-based statistics, incl. coefficients and expected counts)





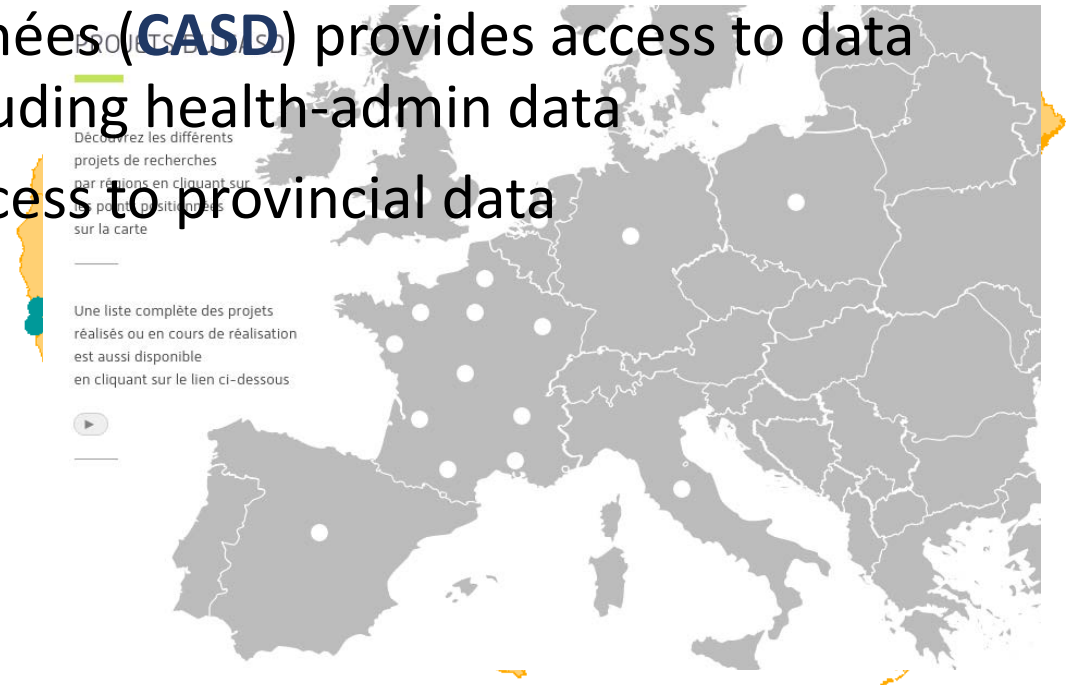
# hidden cost: managing the network

- Categorizing access requests
  - What is an **authorized** institution? [\[Eurostat: recognized research entity\]](#)
  - Framework **contracts** with each institution
- Managing access **requests**
  - Ideally, that's a problem you would like to have
  - **Training** [France: 3h enrollment sessions], managing **access tokens**, [physical thin clients]
  - **Cost?** [\[France: itemized price list\]](#)
- Disclosure avoidance
  - Bottleneck – ideally primary function of designated staff
  - Training of users important [Based on our survey of 100 US FSRDC users]
  - Provision of tools important
  - **Enforcement** (in particular for self-disclosure)



# natural economies of scale

- Increasing emphasis on consolidation of (national) networks
  - **US** Census Bureau's Research Data Centers (since 1990s) now Federal Statistical Research Data Centers (**FSRDC**) with 8 new federal partners
  - **France** Centre d'accès sécurisé aux données (**CASD**) provides access to data from more than 15 national entities, including health-admin data
  - Some **Canadian** RDCs also providing access to provincial data
- Secondary research benefit
  - Ability to **break out of data silos**





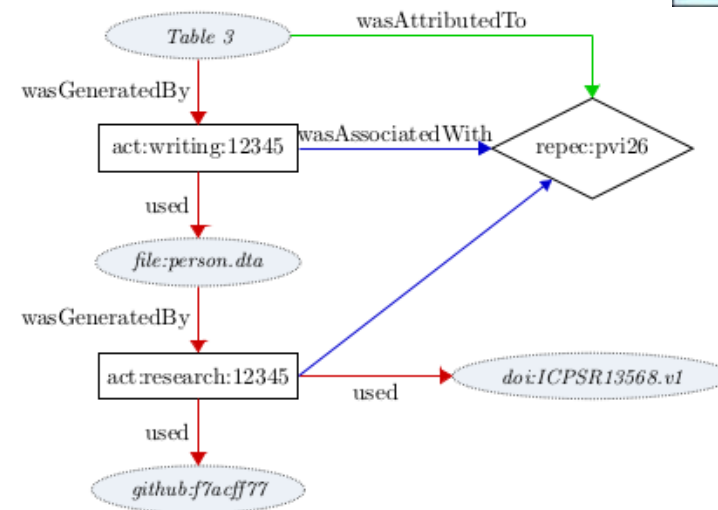
# summary

- Many more tools today than in the past
- **Remote** access of some type is the **standard** practice around the world
- Disclosure avoidance is still quite pedestrian in almost all cases
- Newer methods are being developed, but few access mechanisms (proposed or implemented) successfully combine ability to estimate **arbitrary models** with **robust (provable) protection mechanisms**



# p.s. one last thing

- **Replicability** is a nascent problem
  - More and more journals require provable replicability
  - Cannot be satisfied with **idiosyncratic** access mechanisms
  - Some research with confidential files will **lose** (reputable) publication outlets
- Transparency critical
  - Need capability to be able to **archive** research files within secure enclaves
  - Need ability to **publically identify** such files (documentation) [DDI, DOI]



thank you

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